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Patents Registry, Intellectual Property Department
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Chapter 514
Laws of the Hong Kong Special Administrative Region

The attached is a true copy of the Short-term Patent Application No. 04100430.0 which was deemed to be withdrawn on 24 March 2004.

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Dated this 21st day of January 2005.

(YIP CHIU YING RITA)
Intellectual Property Examiner
for Registrar of Patents

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INTELLECTUAL PROPERTY DEPARTMENT

Patents Form P6
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Fee No. 6

Patents Ordinance
(Chapter 514)

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Application No. 04100430.4 ✓
Accorded filing date

Request for Grant of a Short-Term Patent

Patents Ordinance sections 113, 116, 125
Patents (General) Rules sections 58, 74

(See the notes on the last page of this form)

01 Your reference	9873862:P/D:HALE:sk
02 Applicant's details *(see note (4)(a))*	
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Fax	
Kind of incorporation	limited liability
Country of incorporation	Hong Kong SAR, China
State of incorporation *(if applicable)*	
03 Title of invention *(see note (4)(b))* English	Means and Methods of Sound Synthesizing
Chinese	

04 Details of International Patent Classification *(see note (5))*	IPC Code	IPC Edition No. 7th
05 Use of micro-organisms *(tick the appropriate box)*		
(a) Does the invention require the use of a **micro-organism** for its performance?	☐ Yes ☒ No	
(b) If you have ticked "Yes", please indicate whether the micro-organism is available to the public at the date of filing of the application; and	☐ Yes ☐ No	
whether the micro-organism is described in the application or the specification of the patent in such a manner as to enable the invention to be performed by a person skilled in the art.	☐ Yes ☐ No	
(c) If you have ticked "No" in **both** boxes in (b), please give the following details: Name and address of the depositary institution where a culture of the micro-organism is deposited	Name: Address:	
Date of deposit *(Day/Month/Year)*		
Accession No. of the deposit *(section 73 and Schedule 1, Patents (General) Rules)*		
06 Details of international application If the short-term patent application is based on		
(a) International Application No.		
(b) International Filing Date *(Day/Month/Year)*		
(c) International Publication No.		
(d) International Publication Date *(Day/Month/Year)*		
(e) Date of entry into the national phase in the People's Republic of China	☐ ____________ *(Day/Month/Year)*	
or		
Date of issuance of the National Application Notification by the State Intellectual Property Office *(tick the appropriate box and enter the date in the space provided)*	☐ ____________ *(Day/Month/Year)*	

(f) Application No. of the Chinese patent application (if known) *(section 125, Patents Ordinance and section 78, Patents (General) Rules)*	
07 Details of earlier application If the application is divided or derived from an earlier Hong Kong application (a) Section under which an earlier application is claimed *(see note (6))* *(tick the appropriate box)*	Patents Ordinance ☐ section 116 ☐ section 55
(b) Earlier Application No.	
(c) Earlier Application Filing Date *(Day/Month/Year)*	
08 Details of the priority application If a statement of claim of priority under section 111, Patents Ordinance is made *(sections 58(5)(c), 69, Patents (General) Rules)*	**Statement**

Country	Priority Application No.	Priority Application Filing Date

09 Details of inventor *(see note (4)(a))* *(see note (7))*	
Name *(underline surname)*	Yip Ho Yan Stephen
Name in Chinese *(if applicable)*	葉浩仁
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10 Non-prejudicial disclosure If the applicant is making a claim regarding non-prejudicial disclosure under section 109, Patents Ordinance, please provide a statement giving details relating to such disclosure. *(see note (8))*	**Statement**

Name and place of the exhibition or meeting	Opening date of the exhibition or meeting	Date of first disclosure

11	If a **request for deferral of grant** under section 119, Patents Ordinance is required, please tick the box and enter the period of such deferral. *(the period of deferral should not exceed 12 months)* *(if the box is not ticked, it will be taken that deferral of grant is not requested)*	☒ Request for deferral of grant up to 19/01/2005 *(Day/Month/Year)*
12	**Enter the no. of sheets for any of the following documents you are filing with this form**	No. of sheets
	(a) Continuation sheet for the request	
	(b) Description	15
	(c) Claim(s)	2
	(d) Drawing(s)	15
	(e) Abstract *(in both English and Chinese)*	
	(f) Priority document(s)	
	(g) Translation of the priority document(s)	
	(h) Search Report	
	(i) Translation of the Search Report	
	(j) In the case of an international application, copy of : (i) the international application as published by the International Bureau	
	(ii) the international search report	
	(iii) translation as published by the State Intellectual Property Office	
	(iv) publication of information by the State Intellectual Property Office concerning the international application	
	(k) Statement of inventorship on Patents Form P7 in accordance with section 113(2)(c), Patents Ordinance and section 65, Patents (General) Rules *(see note (7))*	
	(l) Others *(please specify)*	

13	**Name of agent** *(if you have one)*	**Deacons**
	Address for service in Hong Kong	**Alexandra House** **5th Floor** **Central** **Hong Kong**
	Telephone	2825 9336 (Hans Lee)
	Fax	2810 0431
	Agent's code *(if known)*	
14	I/We request the Registrar to grant a short-term patent.	
	Signature	
	Name of signatory	PAUL DAVIES
	Official capacity of signatory	PATENT ATTORNEY
	Date *(Day/Month/Year)*	19 January 2004

MEANS AND METHODS OF SOUND SYNTHESIZING

FIELD OF THE INVENTION

This invention relates to means and methods of sound synthesizing and, more particularly to means and methods of synthesizing the sound of musical instruments and the like. More specifically, although of course not solely limited thereto, this invention relates to the synthesizing of the sound of a string instrument such as violin, bass, cello and piano.

BACKGROUND OF THE INVENTION

Means and methods of sound synthesizing are widely used in the production or reproduction of sound by electronic means. For example, music (including vocal and instrumental), tones (for example, ringing tones and other tones used in mobile telephones) and background sound are commonly synthesized by a digital signal processing means.

It is well known that an audio signal can be represented by a Fourier series and decomposed into a series comprising weighted harmonics of the fundamental frequency. For example, Jean-Claude Risset and Max v. Mathews in the article entitled "Analysis of Musical Instrument Tones" Physics Today, vol. 22, no.2, pp. 23-30 (1969) advanced that the temporal evolution or the evolution in time of the spectral components of a sound is of critical importance in the determination of timbre. They suggested that to simulate a natural sound, the amplitude of each harmonic should be individually controlled as a function of time. In addition, at

least for the production of the trumpet tones, that the attack envelope (that is, the initial envelope characteristic for the trumpet tone) has a distinctive characteristic in that during the attack and also decay portion of the sound, the energy of the various frequency components evolve in complicated ways. To implement the Risset theory with known techniques requires a complex digital computer which individually simulates each frequency component. As a result, a real time music synthesizer of the digital type has not been commercially feasible.

While the Fourier series provides an accurate representation of the signal or sound to be reproduced, the processing power overhead, for example, for calculating up to 20 or 30 harmonics of a particular musical instrument, may be prohibitively high. Such a high processing power may not be available in portable devices not solely dedicated for music or sound generation, for example, mobile phone with tone or music generator. Hence, it is beneficial if there can be provided means and methods for synthesizing sound of a reasonable quality without requiring a high processing power. Furthermore, the increasing popularity of polyphonic ring tone or music synthesis in mobile phones have made the benefits of a more efficient sound synthesizer even more apparent. The FM synthesizing method proposed in US 4,018,121 by Chowning is a well known type of sound synthesizing method without requiring a very high processing power.

However, it is recognized that the sound or timbral quality of the musical sound synthesized by the FM synthesizing method or other more efficient sound synthesizing methods are not satisfactory. In particular, the synthesized sounds of string instruments such as violin, cello, guitar or piano lack the "richness" to be real enough to be appreciated. Hence, it would be highly beneficial if there can be

provided improved means and methods of sound synthesizing so that musical or other sounds can be generated with a reasonable degree of genuineness without requiring excessive computational overhead.

OBJECT OF THE INVENTION

Hence, it is an object of the present invention to provide means and methods of sound synthesizing, especially musical sound, synthesizing with a reasonable degree of genuineness while without requiring an excessive computational overhead. At a minimum, it is an object of this invention to provide means and methods of sound synthesizing for the benefit and choice of the public.

SUMMARY OF THE INVENTION

Broadly speaking, the present invention has described a method of synthesizing the sound of a musical instrument, including the steps of:-

- obtaining samples of the sound of said instrument,
- analysing the harmonics of said samples of said sound,
- selecting harmonics of said sampled sound according to prescribed characteristics of the envelop of said harmonics for synthesizing harmonics of the synthesized sound,
- grouping harmonics of said sampled sound of similar envelop characteristics and obtaining temporal characteristics of the group of harmonics from constituting harmonics of the same group,

- synthesizing a plurality of synthesized harmonics of the synthesized sound, wherein at least some of the synthesized harmonics are synthesised from one of the envelops of the harmonics of a group and conditioned by the temporal characteristics of the constituting harmonics of that group.

Preferably, said prescribed characteristics for selecting a harmonic including selecting a harmonic with more salient variation in amplitude over-time.

Preferably, a plurality of selected harmonics of said sampled sound being group added to form a synthesized harmonic of the synthesized sound.

Preferably, said synthesized harmonic obtained by group addition being scaled up or down for generating other harmonics of said synthesized sound.

Preferably, said synthesized sound being synthesized from a plurality of characteristic harmonics, a plurality of said characteristic harmonics having a substantially similar envelope.

Preferably, the number of said plurality of characteristic harmonics does not exceed 4.

Preferably, at least one of said characteristic harmonics being synthesized from a plurality of harmonics of said samples of said sound.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will be explained in further detail below by way of examples and with reference to the accompanying drawings, in which:-

Fig. 1 is a three-dimensional diagram showing the amplitude-time-harmonics relationship of a sample of a "Synstring" sound obtained by FM synthesis,

Fig. 2 is a chart showing the amplitude-time relationship of the first harmonic of the Synstring signal of Fig. 1,

Figs. 3-6 show respectively the amplitude-time relationship of the second, third and fourth harmonics of the Synstring signal of Fig. 1,

Fig. 7 shows the amplitude-time chart of the fifth to the eighth harmonics of the Synstring signal of Fig. 1,

Fig. 8 shows the wavetable of the first synthesized harmonic,

Figs. 9 and 10 respectively show the wavetable for the second and the third synthesized harmonics;

Fig. 11 shows the wavetable of the fourth group of the synthesized harmonics,

Fig. 12 shows the synthesized harmonics of the synthesized sound from the four groups of synthesized harmonics and their respective wavetables,

Fig. 13 shows, from top left and clockwisely, respectively, the envelops (amplitude-time) variation of the first to the fourth synthesized harmonic groups,

Fig. 14 shows the amplitude-harmonics and time chart of the four most dominant harmonics of the sampled sound,

Fig. 15 is an amplitude-time diagram showing the waveform of the sound of a Synstring signal synthesized by the group additive synthesis of this invention,

Fig. 16 shows the spectral diagram of the harmonics of the synthesized sound formed by the four groups of the synthesized harmonics.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to obviate the need of a dedicated processor with a high processing power to provide synthesized sound or musical sound of a reasonable timbral quality, the present invention provides means and methods to synthesize a musical sound from a plurality of synthesized characteristic harmonics. The synthesized characteristic harmonics are then used to synthesize additional harmonics to provide the desirable timbral quality. Hence, the musical sound of a reasonable quality can be constructed from a selected plurality of synthesized harmonics, thereby alleviating the need of exhaustive competition.

Referring firstly to the exemplary spectrum of Fig. 1 showing the harmonics of a Synstring signal sample of Fig. 1 and the schematic representation of 8 showing the more salient or dominant harmonics of the Synstring signal. It will be noted that among the 20 harmonics shown in the Figures, the amplitude-time variation of the first eight harmonics are particularly noticeable or salient. Hence, they are of substantial practical audio importance since their amplitudes are of those sufficient significance. Thus, it will be appreciated that the Synstring signal can be adequately represented by the first 8 harmonics. However, to

synthesize the sound using all the 8 harmonics still requires a very substantial processing power as well as data storage which are not sufficiently efficient for many practical applications. In this context, it will be appreciated that the term "Synstring" is known to persons skilled in the art as the synthesized sound of a string instrument such as violin, viola, cello, guitar and piano, which has been used here as a convenient illustrative example.

In this preferred embodiment, the plurality of the characteristic synthesized harmonics are synthesized from the 8 more dominant or salient harmonics of the sampled sound to produce a lesser plurality of synthesized harmonics for constructing the synthesized sound with the necessary timbral quality.

In this example, 4 characteristic synthesized harmonic groups are produced first.

As can be seen from Figs. 1 and 7, the first harmonic of the sampled sound has the most dominant amplitude characteristics. Hence, it is selected as the first group of the synthesized harmonic. Thus, the envelope of the first harmonic of the sampled sound is also the envelope of the first synthesized harmonic of the synthesized sound.

The second synthesized harmonic group is built from the second and the third harmonics of the sampled sound. Such a grouping selection is made because the second and the third harmonics exhibit similar characteristics on variations of amplitude with time (as reflected by the trend of the tooth-shaped envelope).

The envelope of the third harmonic of the sampled sound is used as a reference for synthesizing the envelope of the second group of synthesized harmonics of the synthesized sound because the envelope of the third harmonic has the larger and therefore more dominant amplitude in this group.

The third group of the synthesized harmonic of the synthesized sound consists of the fourth harmonic of the sampled sound since it can be seen that the fourth harmonic has a unique amplitude-time variation which is very different from the remaining of the harmonics of the sampled sound. Hence, the envelope of the third group of the synthesized harmonics is also the envelope of the fourth harmonic of the sampled sound.

As the remaining harmonics of the sampled sound, namely, the fourth to eighth harmonics, have a similar saw-tooth envelop trend and have comparable relative amplitudes, it is believed that they represent the similar timbral quality and could be grouped together to form one of the synthesized harmonics. Furthermore, as the shape of the saw-tooth envelop of the sixth harmonic is more salient, that is, the amplitude between adjacent peaks and troughs are more significant, the envelop of the sixth harmonic is chosen as a normalizing reference and envelop to be explained below.

To construct the synthesized harmonics, a plurality of wavetables is constructed. As a convenient example, the wavetable has a table size of 128 entries. As a full signal cycle can be represented by a cycle of 360°, each entry in the wavetable represents 2.8125°. For an exemplary 16 bit system, the signal amplitude can be resolved into 32767 levels. An exemplary wavetable

constructed for the first harmonic of the sampled sound is shown in Table A below as a convenient example.

Degree	Radian	First harmonic	32767
0	0	0	0
2.8125	0.049087	0.049068	1607
5.625	0.098175	0.098017	3211
...	...	...	...
360	6.2832	0	0

TABLE A

As the second synthesized harmonic group is constructed from the second and third harmonics of the sampled sound, the wavetable is constructed by adding the corresponding temporal amplitude values of the second and third harmonics. The amplitude values of the second harmonic set out in Table B is normalized by the scale of 0.988. This normalizing factor is obtained by dividing the value of the plague amplitude of the second harmonic which is 4359 on the 32767 level by the peak amplitude value 4413 of the third harmonic, that is, 4359/4413 = 0.988. The maximum sum obtained by adding 0.988 x amplitude of the second harmonic + the amplitude of the third harmonic is about 1.9 (referred to the entry under 30.9375°). Hence, this sum is scaled down or normalized by the factor of 1.9 to ensure that the maximum does not exceed 1 or 32767. Then the same factor 1.9 is used to scale up the time-amplitude envelope of third harmonic to compensate for the scaled down of the wavetable.The wavetable of the third group as constructed from the scaled down sum of Table B is graphically represented in Fig. 9 as the wavetable.

As the third synthesized harmonic group consists only of the fourth harmonic of the sampled sound, the wavetable of the third synthesized harmonic

group is equal to the wavetable of the fourth harmonic of the sampled sound, as illustrated in Fig. 11. Next, the fourth synthesized harmonic group is further synthesized by group additive synthesis of the fifth to the twelve harmonics by adding corresponding temporal values of the amplitudes of the respective harmonics, as shown in more detail by the tabulation of Fig. C which shows a portion of the calculation. In constructing this fourth group of synthesized harmonic, the envelope of the sixth harmonic is used as a reference because of its more salient saw-tooth features. Before group adding the harmonics, the fifth harmonic is scaled up or normalized by the factor of 1.25 which is the ratio between the peak amplitude of the fifth harmonic (3389) and the sixth harmonic (2719) (1.25 = 3389/2719). This normalization before adding is repeated for the other harmonics. Although all the fifth to twelve harmonics are used in this tabulation, it will be appreciated that the harmonics beyond the eighth are already less significant and their inclusion is merely for further enhancement of a timbral quality while the inclusion of the fifth to the eighth harmonics would have given a reasonable timbral quality already. As can be seen from the "sum" column of Table C, the maximum value of the added amplitude is about 2.16. Hence, the added sum will be scaled down by factor of 2.2 to avoid overflow of the 16 bit system. Again the time-amplitude envelope of the sixth harmonic has to be scaled up by the same factor 2.2 to compensate for the scale down of the wavetable. After the four synthesized groups have been constructed, the four characteristic synthesized harmonic groups will be used to construct the synthesized sound. Specifically, the first harmonic of the synthesized sound is constructed by multiplying the first wavetable with the first harmonic of the sampled sound. The second synthesized harmonic constructed by multiplying the second wavetable

(obtained by combination of the second and the third harmonics) with the scale up third harmonic of the sampled sound. The third synthesized harmonic is obtained by multiplying the third wavetable, which is obtained from the fourth harmonic of the original sampled sound, with the fourth scale up harmonic of the sampled sound.

Next, the fourth synthesized harmonic group is constructed from the fourth wavetable and the sixth harmonic by multiplication since the sixth harmonic has a more dominant saw-tooth envelop. The amplitude-time envelope of the first to the fourth synthesized harmonic groups and the amplitude-harmonic-time spectral diagram are respectively set out in Figs. 13 and 14.

The amplitude-time envelopes of the first to the fourth synthesized harmonic groups are sliced into a plurality of intervals of 0.02 s width. Arrays containing the values of individual time-amplitude envelopes are constructed from the selected envelopes normalized by the scale up factor (i.e. envelopes of the first harmonic, third harmonic with scale up factor 1.9, fourth harmonic and sixth harmonic with scale up factor 2.2). Due to the changes of the relative amplitude of the envelopes against each other, the temporal evolution characteristic of musical sound can be synthesized. Furthermore, the amplitude value of a particular synthesized harmonic group at a particular time is looked up from the array. The value is then multiplied by the corresponding level value from the wavetable at the desired frequency. Put simply, the wavetable is to synthesize the spectrum of a musical sound. The time-amplitude envelope is to synthesize the temporal evolution of a musical sound. These two are the most two important characteristics of synthesizing a musical sound.

As the respective wavetables for the particular synthesised harmonic contain the values of the relevant temporal evolution information of the respective constituting harmonics of the sampled sound, the multiplication by the wavetables of the selected harmonic envelope imparts the quality of the constituting sampled harmonics to the selected envelope. For example, the second synthesized harmonic group is built on the time-amplitude envelope of the third harmonic of the sampled, by multiplying the envelope of the sampled third harmonic with the second wavetable which contains temporal evolution elements of both the second and the third sampled harmonics, the temporal characteristics of the second and third sampled harmonics are imparted onto the second synthesized harmonic. This applies mutatis mutandis to the fourth synthesised group.

As a specific example, the synthesizing of a 440 Hz Synstring signal at a sampling rate of 44 kHz is illustrated. As the lookup wavetable has a total of 128 entries, each entry on the wavetable will represent 344.5 Hz (44.1kHz/128).

At 344.5Hz, the lookup address of the wavetable needs to be incremented by one to obtain the desired first harmonic wavetable. If we want to have a frequency of 440Hz is desired, the index will be exceeding 1 for the lookup address of the wavetable which is given by the following formula:

e.g., the index will be 440Hz/344.5Hz=1.277

That means at each sampling at 44.1kHz, the lookup address will be incremented by 1.277 instead of 1 and the desired 440Hz can be represented by the 128 entries of the first harmonic wavetable.

To regenerate the sound of a Synstring signal at frequency 440Hz, the corresponding table and amplitude will be multiplied and the four groups of synthesized harmonics will be lumped together.

An example of a simple program to synthesize the 440Hz Synstring sound is set out below.

Accumulator : wavetable lookup address
Index: increment at the desired frequency
Table: table array of the wavetable above
Coefficient: a calculated result from table array of the amplitude above,
Synstring: the pcm output value

At 44.1kHz sampling, the output is calculated at the sampling as follows:

```
Accumulator = Accumulator+Index;
if (Accumulator>=128)
        Accumulator = Accumulator-128;
Synstring=Table1[Accumulator]*Coefficient1;
Synstring=Synstring+Table2[Accumulator]*Coefficient2;
Synstring=Synstring+Table3[Accumulator]*Coefficient3;
Synstring=Synstring+Table4[Accumulator]*Coefficient4;
```

The coefficient is calculated at every 0.02sec as follows:

Coefficient: the calculated result from amplitude and volume
Scale: the scaling factor to normalize the volume of a musical instrument with other musical instrument
Volume: the sound volume of the desired musical instrument

The amplitude loop-up from the amplitude envelope using the elapsed time as the lookup address will be as follows:

For example, the elapsed time from the turn on of Synstring instrument at 440Hz is 0.03sec, the amplitude at 0.02sec is used. If the volume is 10 and the scale factor is 5, the coefficient for amplitude1 is 8852*10*5 = 442600. Hence,

442600 will be the Coefficient1 above until the end of 0.04 sec which will be used as the next value to 8852 in the line.

The synthesized waveforms of the exemplary 440Hz Synstring sound in a spectral harmonics representation are shown respectively in Figs. 15 and 16.

It will be noted from the spectral diagram of Fig. 16 that the spectrum of the synthesized sound obtained from the above group additive synthesis is more uniform than that obtained from FM synthesis or the original sample. It will be appreciated that by using group additive synthesis, less processing power and memory can be used to synthesize musical sound without noticeable difference compared to the actual or real instrument to the audience. In mathematical form, the synthesizing of the signal can be represented by the formula below.

In general, audio signals can be represented by as follows:

Where,
$S(t)$: Signal at time t,
$Ai(t)$:Amplitude of ith harmonic at time t,
$S(t)=\Sigma i\ Ai(t)*\sin(2*\pi*i*f*t)$, and
i from 0 to n

In the sound of Synstring, this is reduced to as follows:

$$S(t) = B1(t)*\sin(2*\pi*f*t) + B2(t)*(0.988*\sin(2*\pi*2*f*t)+\sin(2*\pi*3*f*t))+$$

$$B3(t)*\sin(2*\pi*4*f*t)+$$
$$B4(t)*(-1.25*\sin(2*\pi*5*f*t))+\sin(2*\pi*6*f*t))+\ldots)$$

Where B(t) is the normalized amplitude envelope.

This allows the sound to be generated by only 4 table lookups, 4 multiplications and 4 additions at the prescribed sampling rate which greatly reduces the processing power required.

While the present invention has been explained by reference to the examples or preferred embodiments described above, it will be appreciated that those are examples to assist understanding of the present invention and are not meant to be restrictive. The scope of this invention should be determined and/or inferred from the preferred embodiments described above and with reference to the Figures where appropriate or when the context requires. In particular, variations or modifications which are obvious or trivial to persons skilled in the art, as well as improvements made thereon, should be considered as falling within the scope and boundary of the present invention.

Furthermore, while the present invention has been explained by reference to the specific ground additive synthesis outlined above, it should be appreciated that the invention can apply, whether with or without modification, to other synthesizing scheme utilizing a plurality of the harmonics of the sampled sound to construct the synthesized sound without loss of generality.

CLAIMS

1. A method of synthesizing the sound of a musical instrument, including the steps of:-

   - obtaining samples of the sound of said instrument,
   - analysing the harmonics of said samples of said sound,
   - selecting harmonics of said sampled sound according to prescribed characteristics of the envelop of said harmonics for synthesizing harmonics of the synthesized sound,
   - grouping harmonics of said sampled sound of similar envelop characteristics and obtaining temporal characteristics of the group of harmonics from constituting harmonics of the same group,
   - synthesizing a plurality of synthesized harmonics of the synthesized sound, wherein at least some of the synthesized harmonics are synthesised from one of the envelops of the harmonics of a group and conditioned by the temporal characteristics of the constituting harmonics of that group.

2. A method of claim 1, wherein said prescribed characteristics for selecting a harmonic including selecting a harmonic with more salient variation in amplitude over-time.

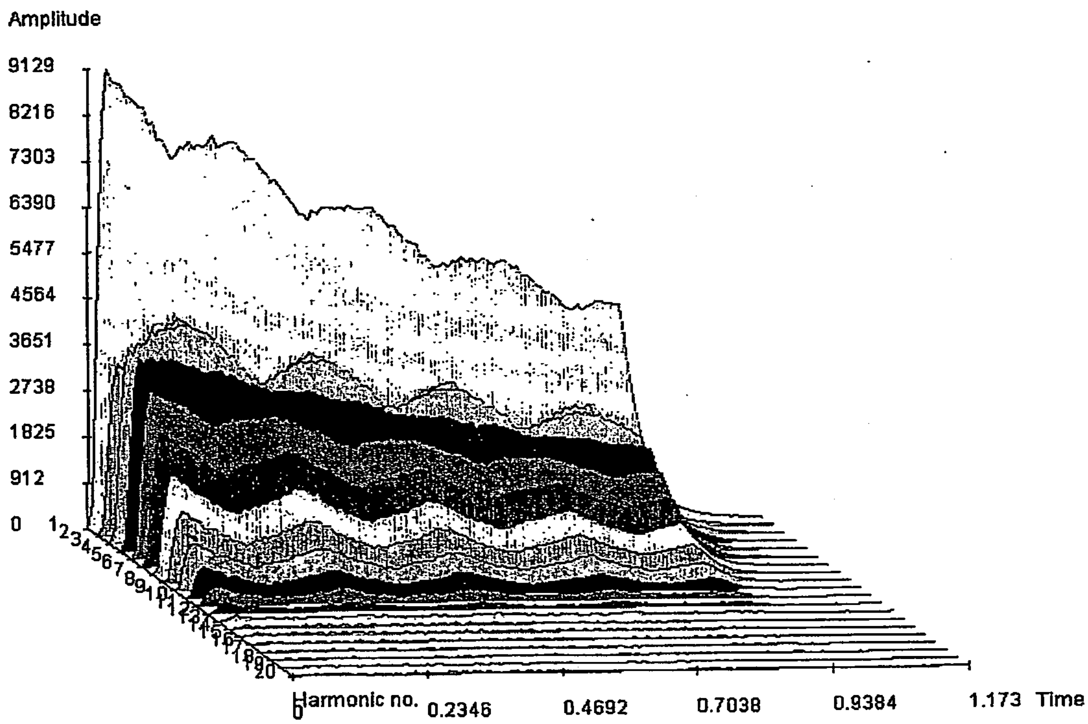
3. A method of claim 1, wherein a plurality of selected harmonics of said sampled sound being group added to form a synthesized harmonic of the synthesized sound.

4. A method of claim 3, wherein said synthesized harmonic obtained by group addition being scaled up or down for generating other harmonics of said synthesized sound.

5. A method of claim 1, wherein said synthesized sound being synthesized from a plurality of characteristic harmonics, a plurality of said characteristic harmonics having a substantially similar envelope.

6. A method of claim 5, wherein the number of said plurality of characteristic harmonics does not exceed 4.

7. A method of claim 5, wherein at least one of said characteristic harmonics being synthesized from a plurality of harmonics of said samples of said sound.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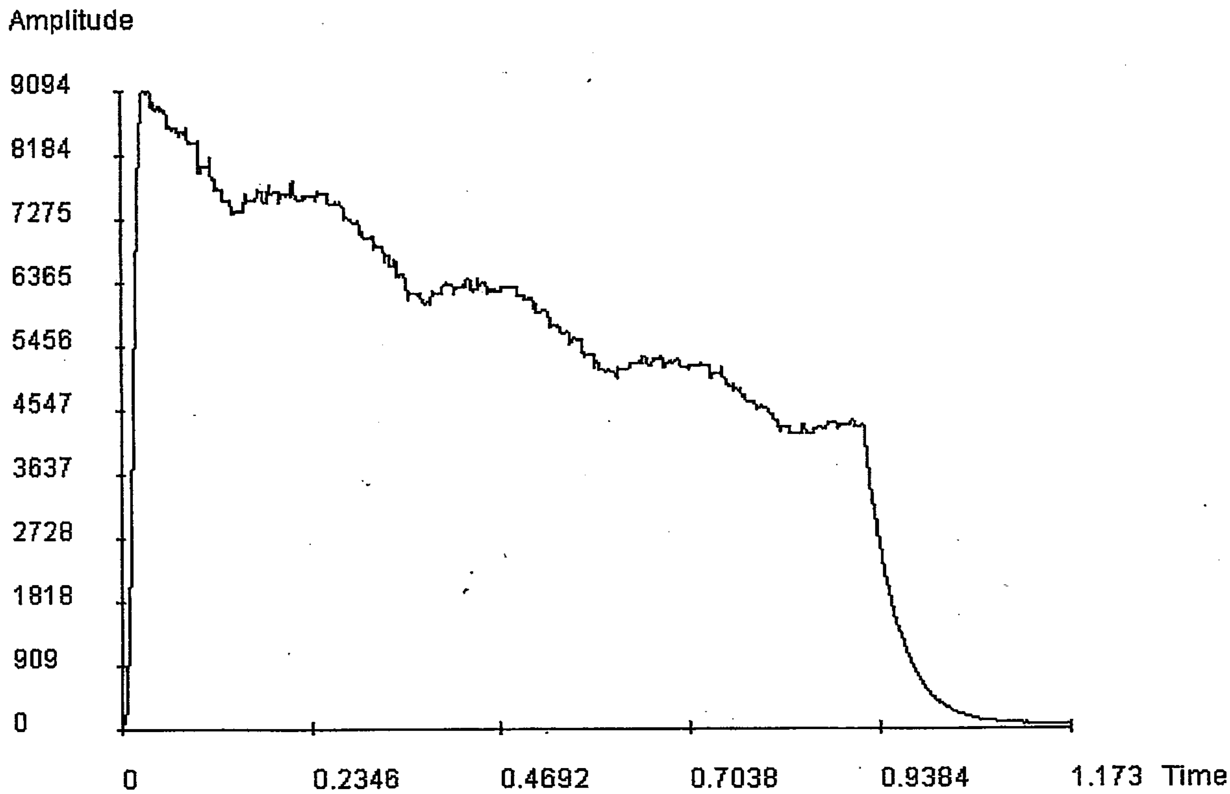
8216
7303
6390
5477
4564
3651
2738
1825
912
0
Harmonic no.
0
0.2346
0.4692
0.7038
0.9384
1.173
Time

FIG. 1



Amplitude
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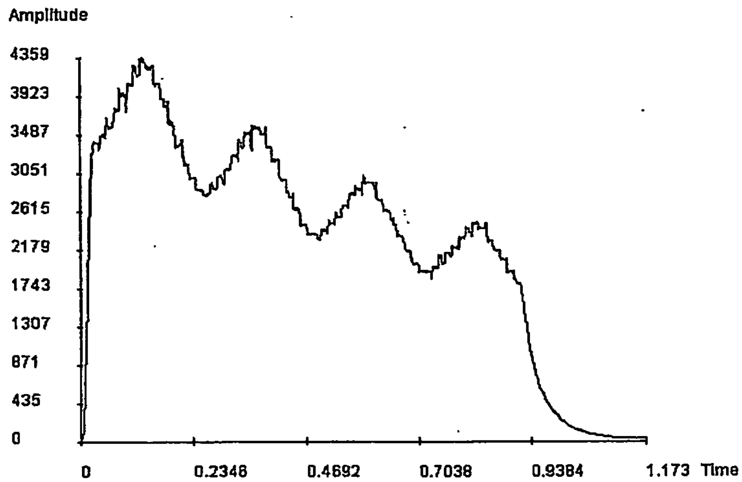
7275
6365
5456
4547
3637
2728
1818
909
0
0
0.2346
0.4692
0.7038
0.9384
1.173
Time

FIG. 2


Amplitude
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2615
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1743
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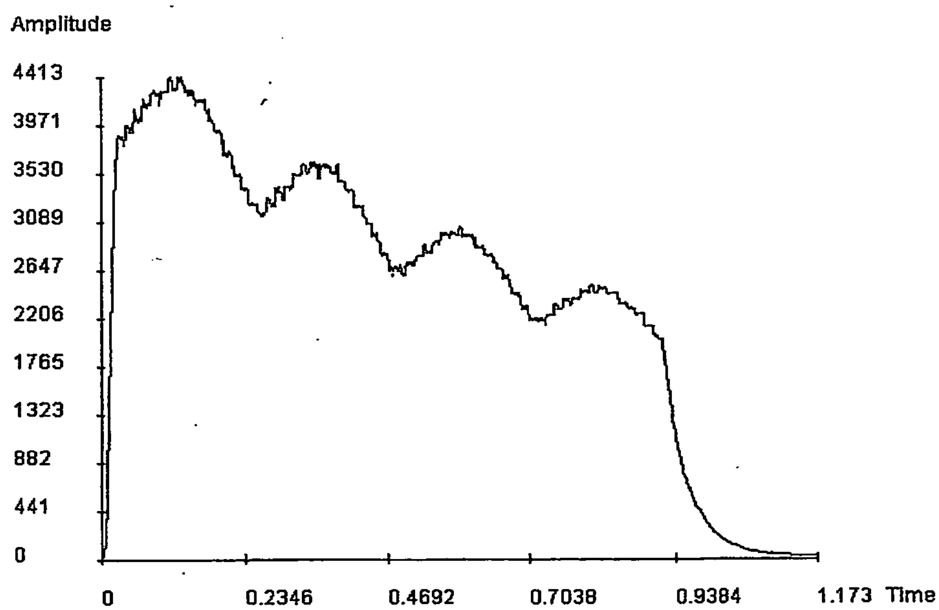
0.9384
1.173
Time

FIG. 3


Amplitude
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0.2346
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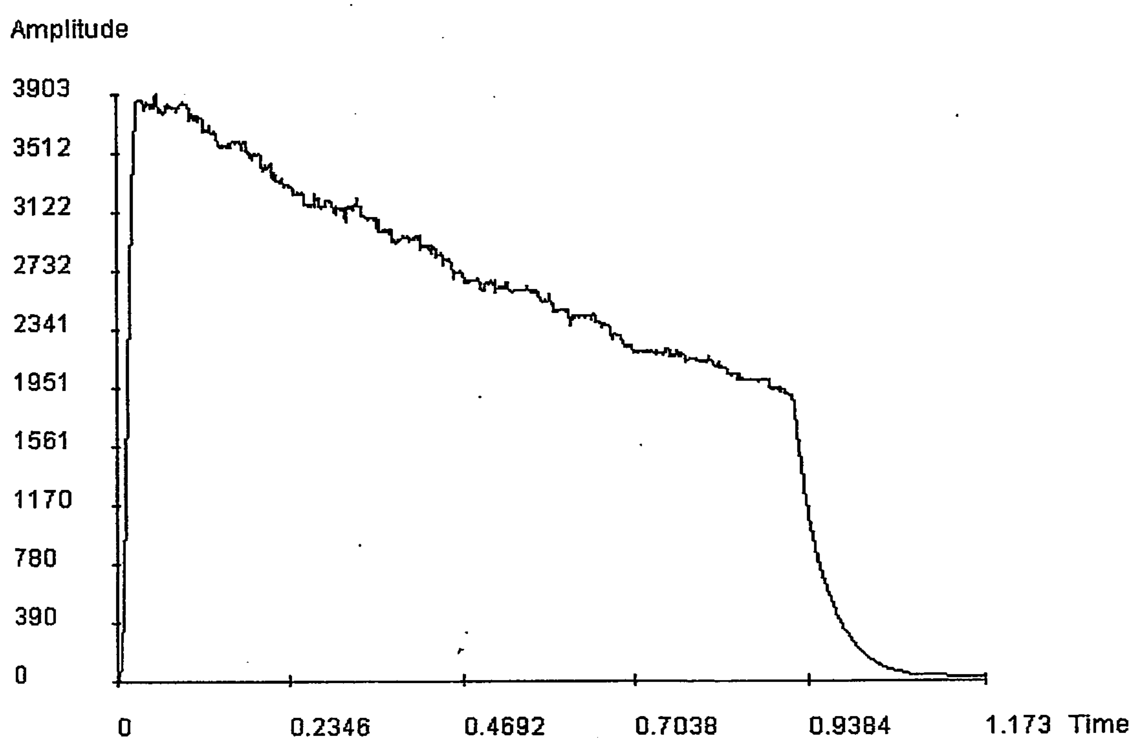
0.7038
0.9384
1.173
Time

FIG. 4


Amplitude
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3122
2732
2341
1951
1561
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780
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0
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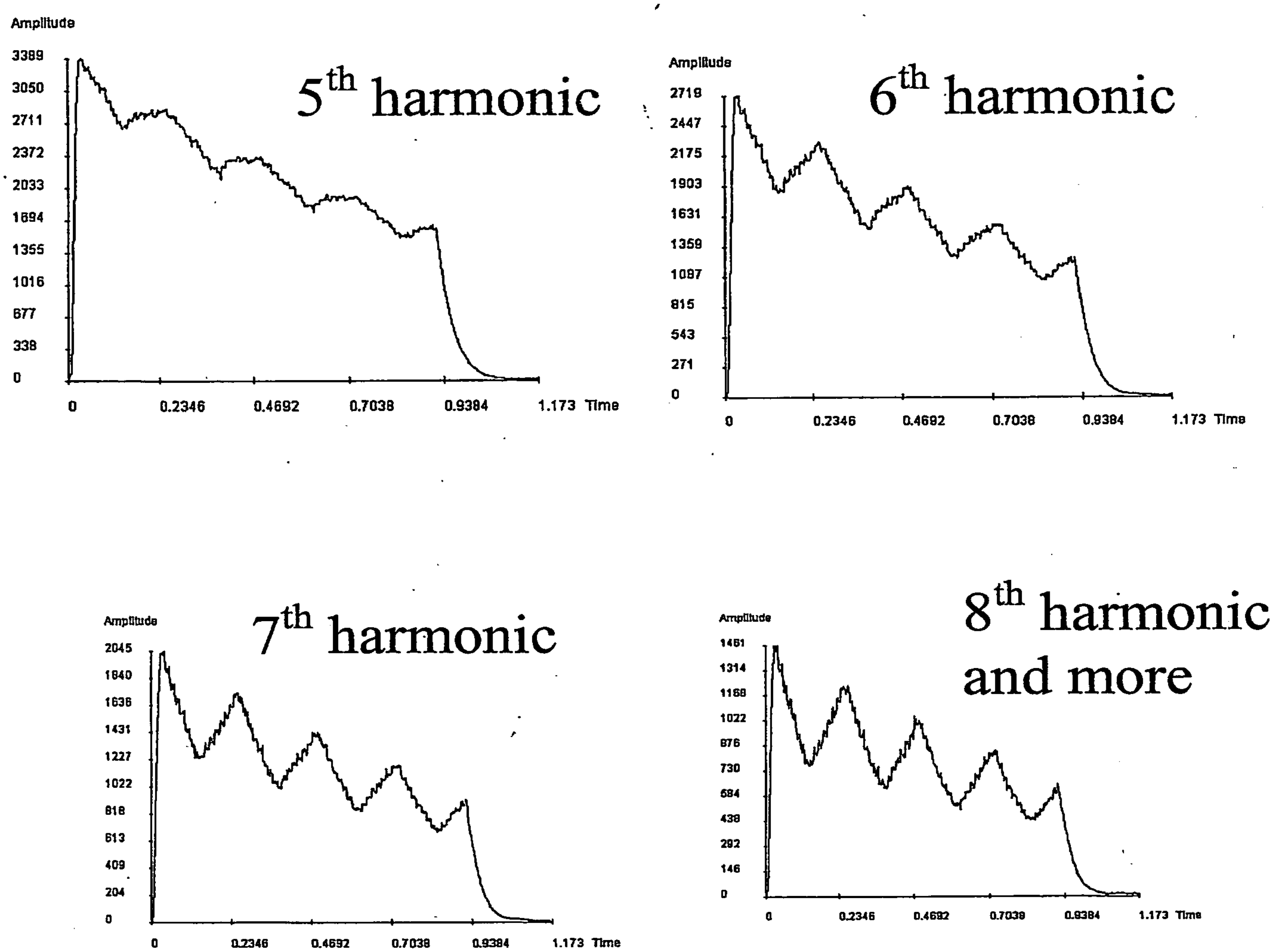
0.4692
0.7038
0.9384
1.173 Time

FIG. 5


Amplitude
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3050
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2033
1694
1355
1016
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0.7038
0.9384
1.173 Time
5th harmonic
Amplitude
2719
2447
2175
1903
1631
1359
1087
815
543
271
0
0
0.2346
0.4692
0.7038
0.9384
1.173 Time
6th harmonic
Amplitude
2045
1840
1636
1431
1227
1022
818
613
409
204
0
0
0.2346
0.4692
0.7038
0.9384
1.173 Time
7th harmonic
Amplitude
1461
1314
1168
1022
876
730
584
438
292
146
0
0
0.2346
0.4692
0.7038
0.9384
1.173 Time
8th harmonic
and more

FIG. 6

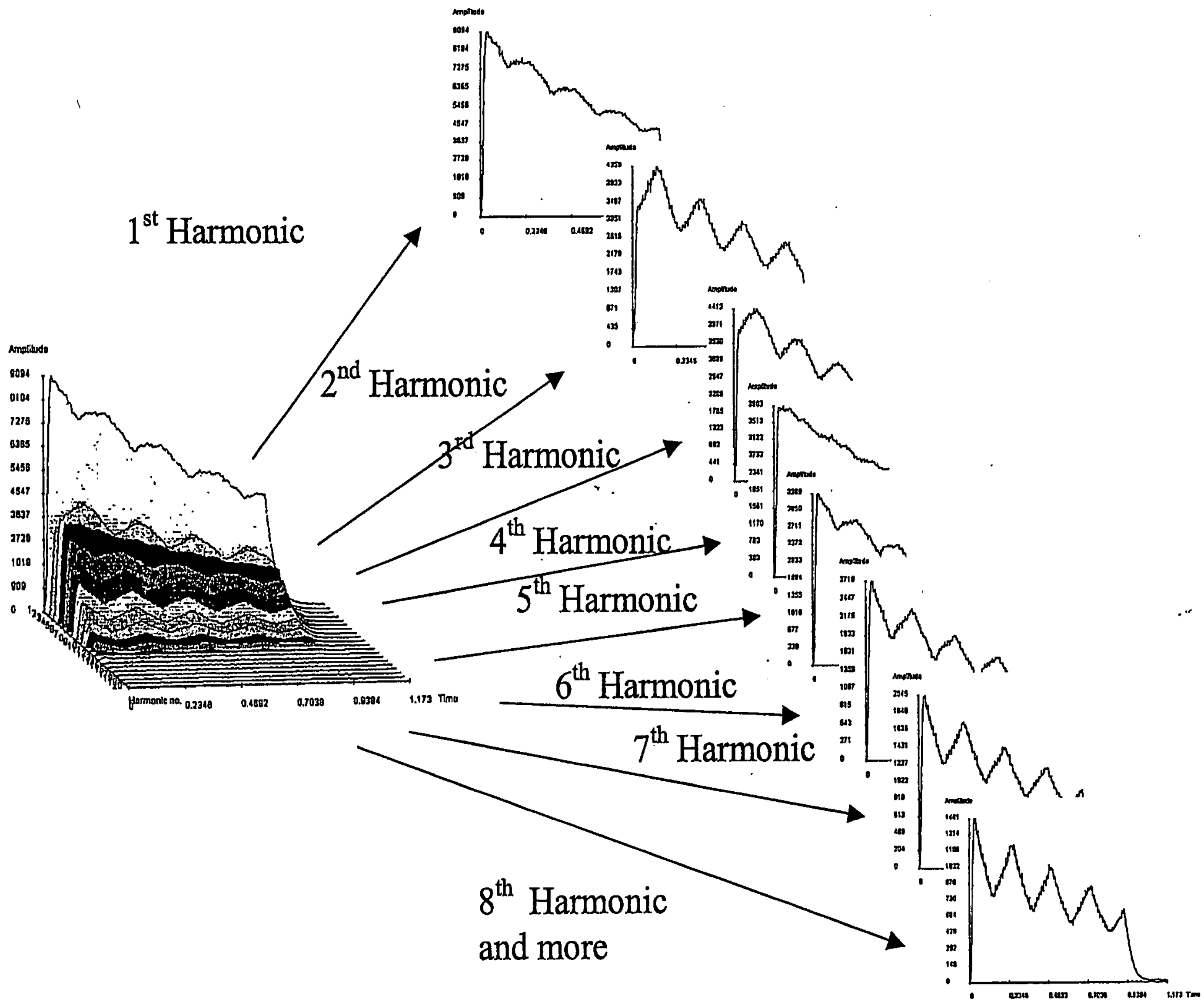
1st Harmonic
2nd Harmonic
3rd Harmonic
4th Harmonic
5th Harmonic
6th Harmonic
7th Harmonic
8th Harmonic and more
Amplitude
Harmonic no.
Time

FIG. 7

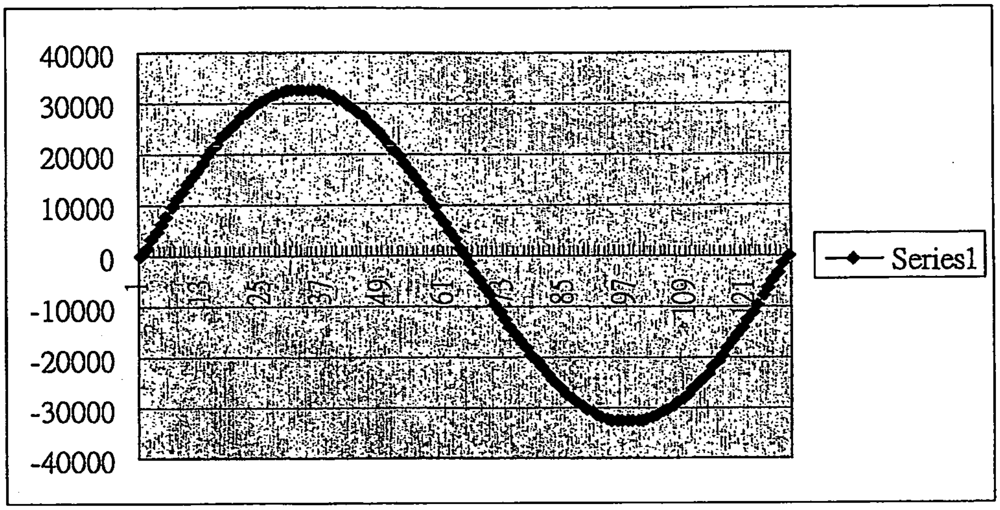
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1
13
25
37
49
61
73
85
97
109
121
Series1

FIG. 8

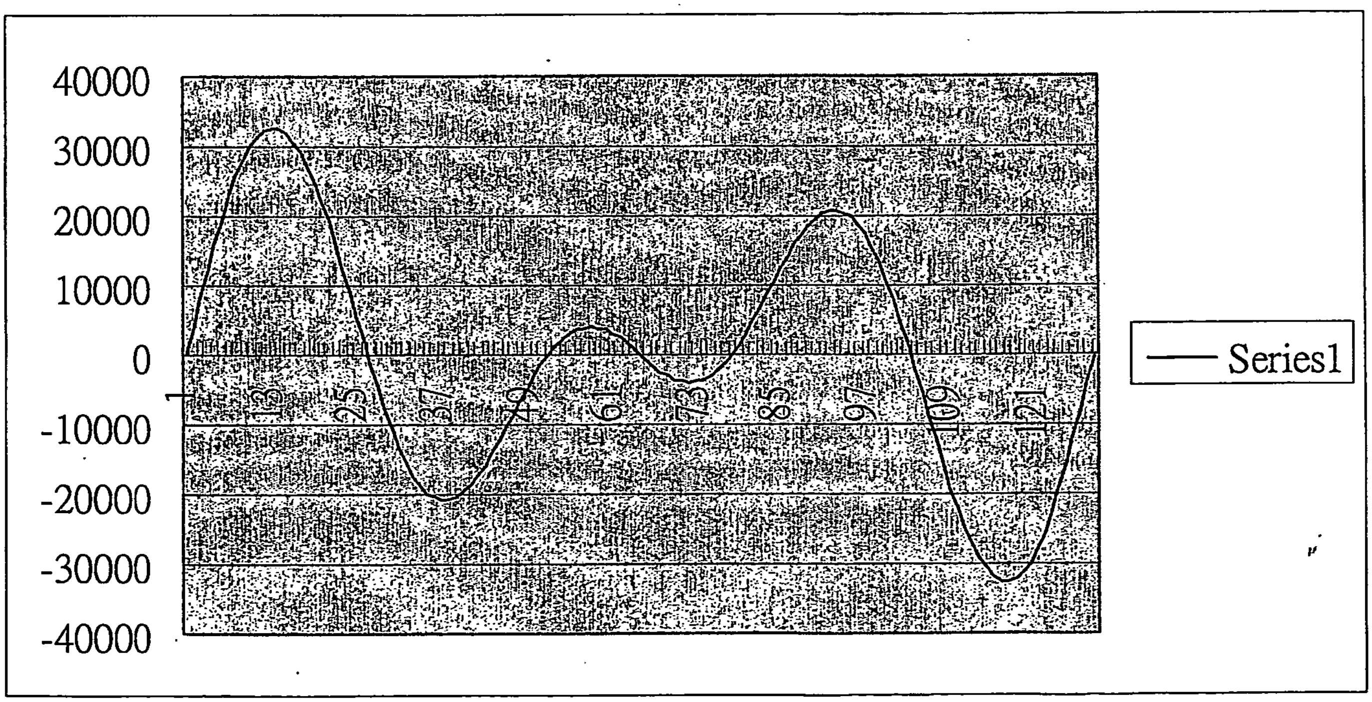
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1
13
25
37
49
61
73
85
97
109
121
Series1

FIG. 9

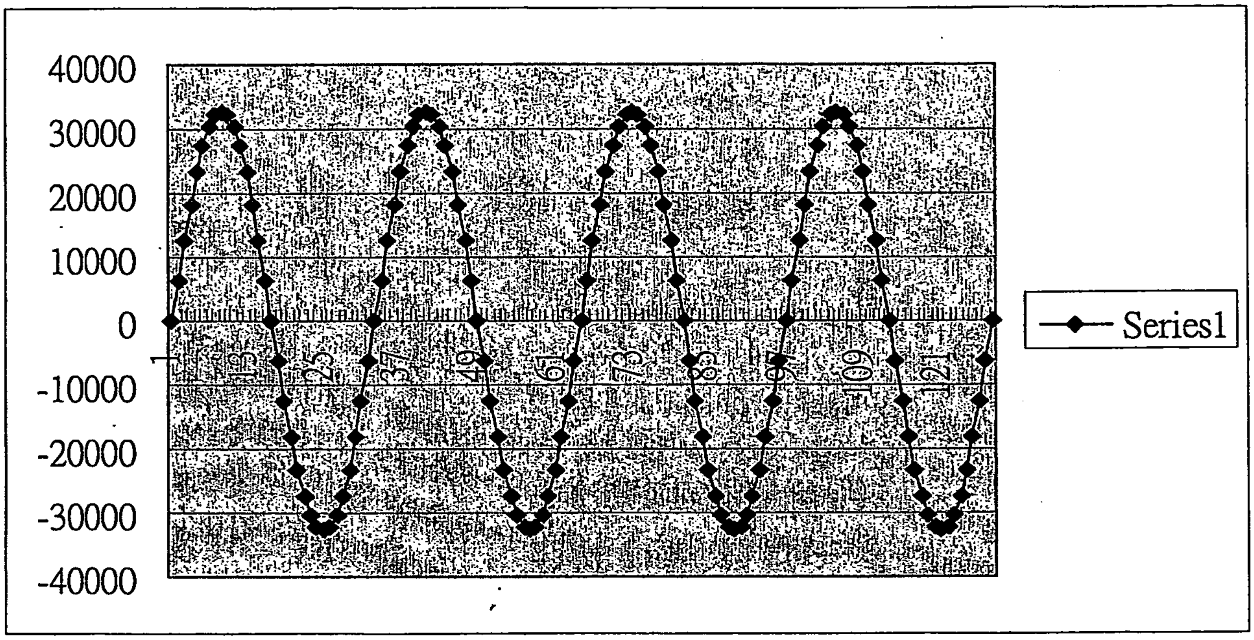
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1
13
25
37
49
61
73
85
97
109
121
Series1

FIG. 11

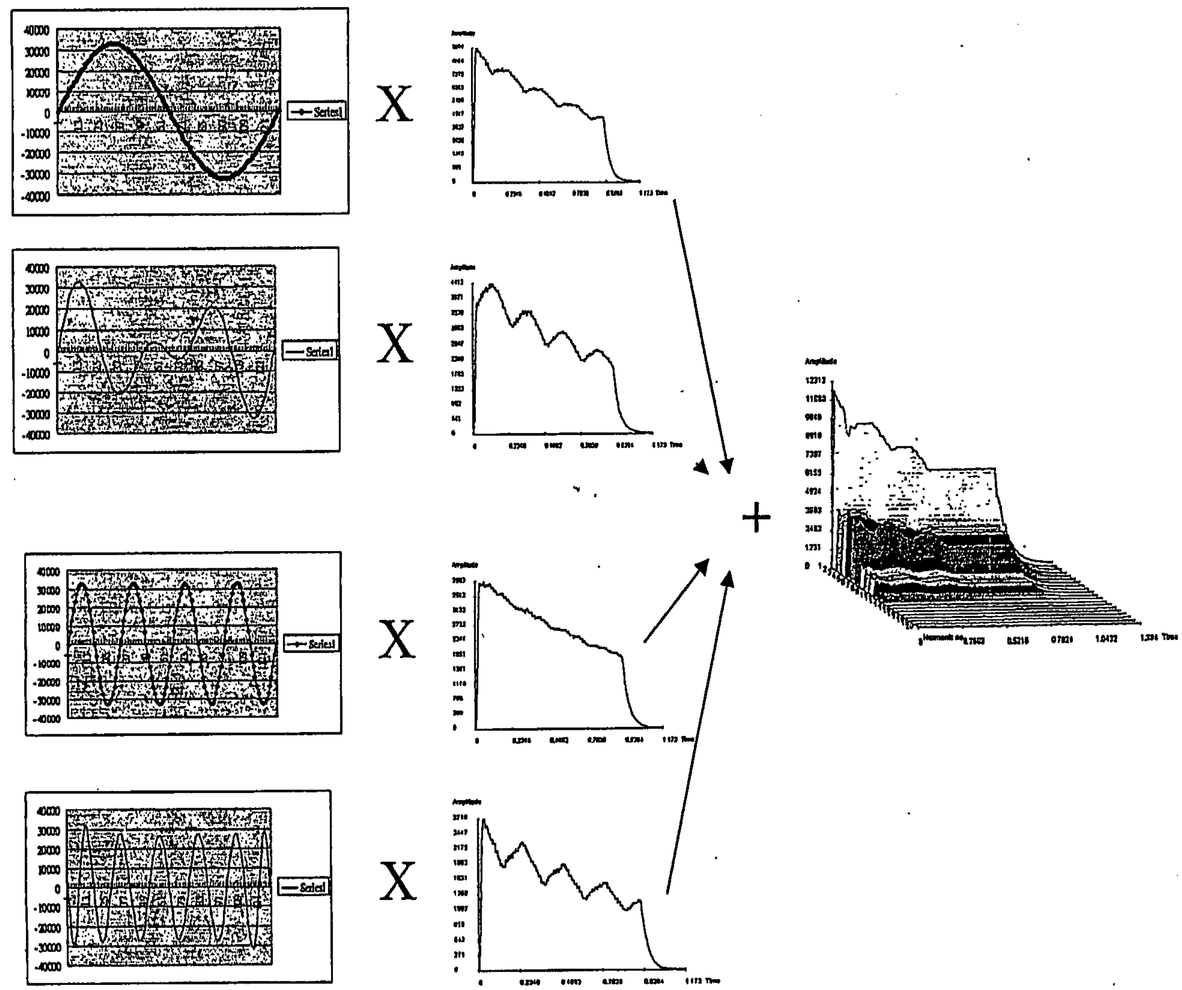

FIG. 12

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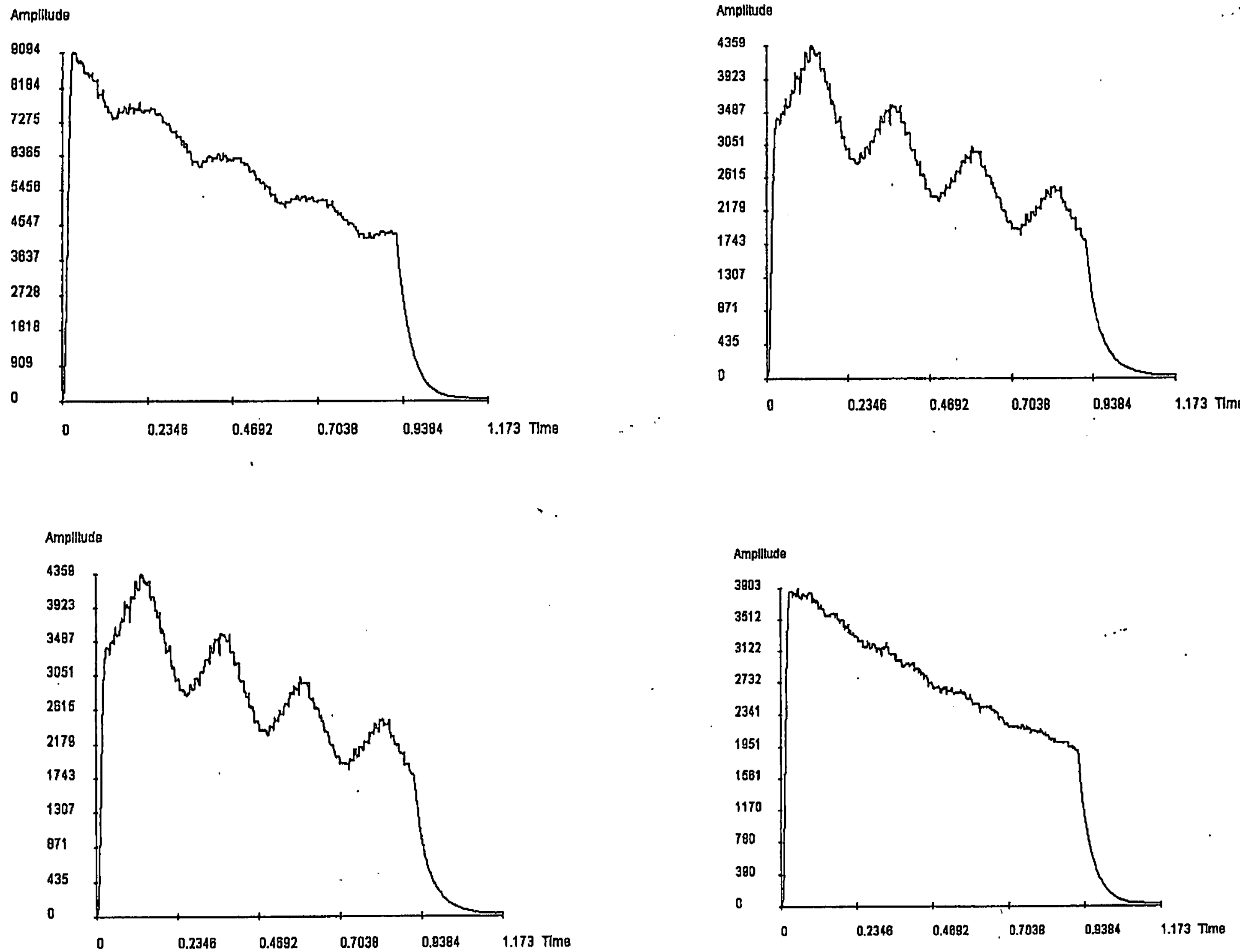
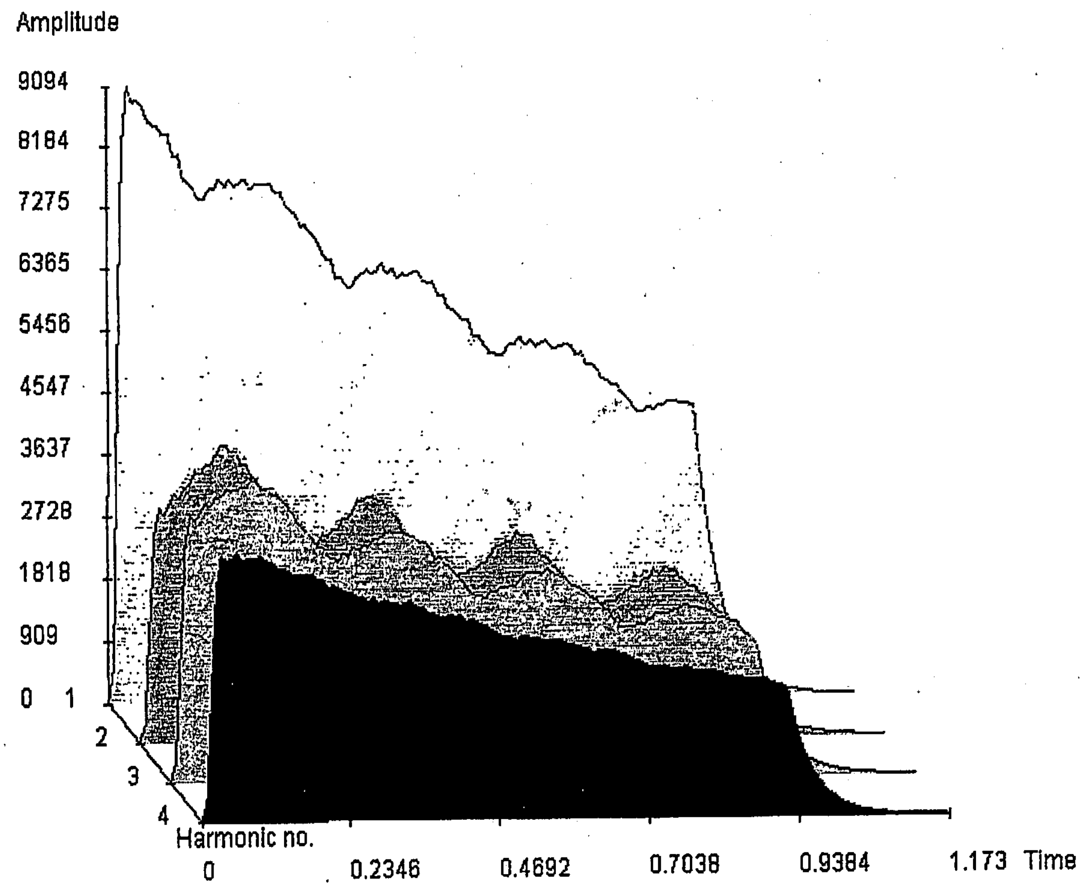

Amplitude
8094
8184
7275
6365
5456
4547
3637
2728
1818
909
0
0
0.2346
0.4692
0.7038
0.9384
1.173 Time
Amplitude
4359
3923
3487
3051
2615
2179
1743
1307
871
435
0
0
0.2346
0.4692
0.7038
0.9384
1.173 Time
Amplitude
4359
3923
3487
3051
2615
2179
1743
1307
871
435
0
0
0.2346
0.4692
0.7038
0.9384
1.173 Time
Amplitude
3903
3512
3122
2732
2341
1951
1561
1170
780
390
0
0
0.2346
0.4692
0.7038
0.9384
1.173 Time

FIG. 13



Amplitude
9094
8184
7275
6365
5456
4547
3637
2728
1818
909
0
1
2
3
4
Harmonic no.
0
0.2346
0.4692
0.7038
0.9384
1.173
Time

FIG. 14

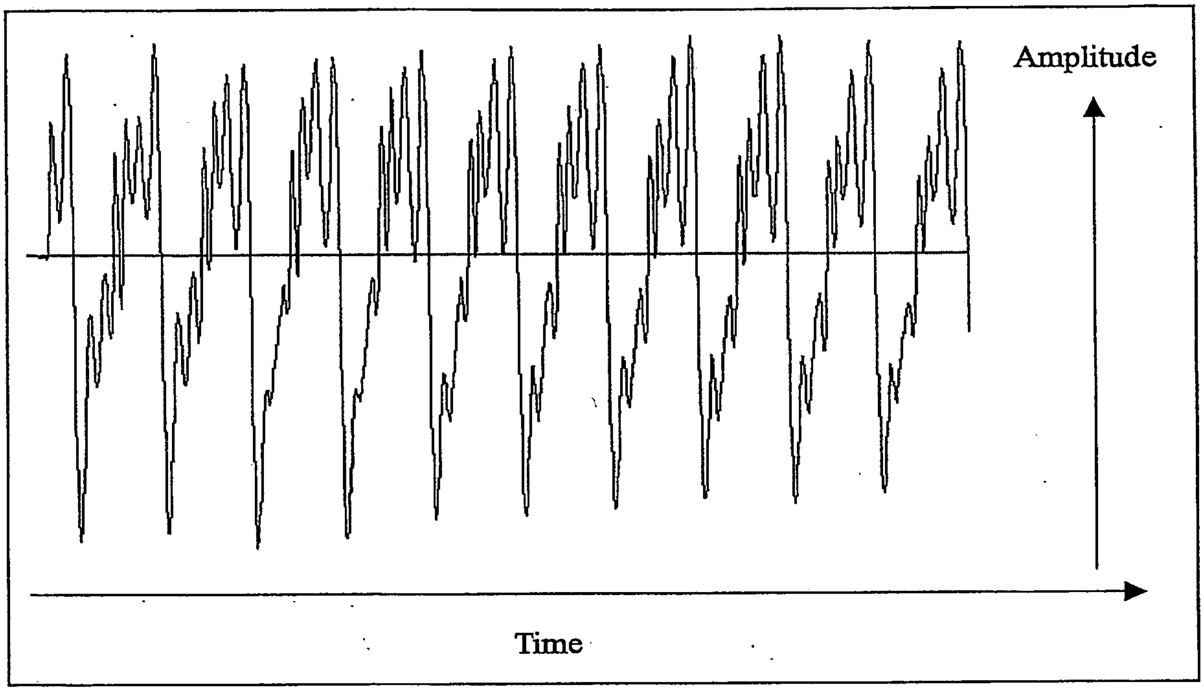


FIG. 15

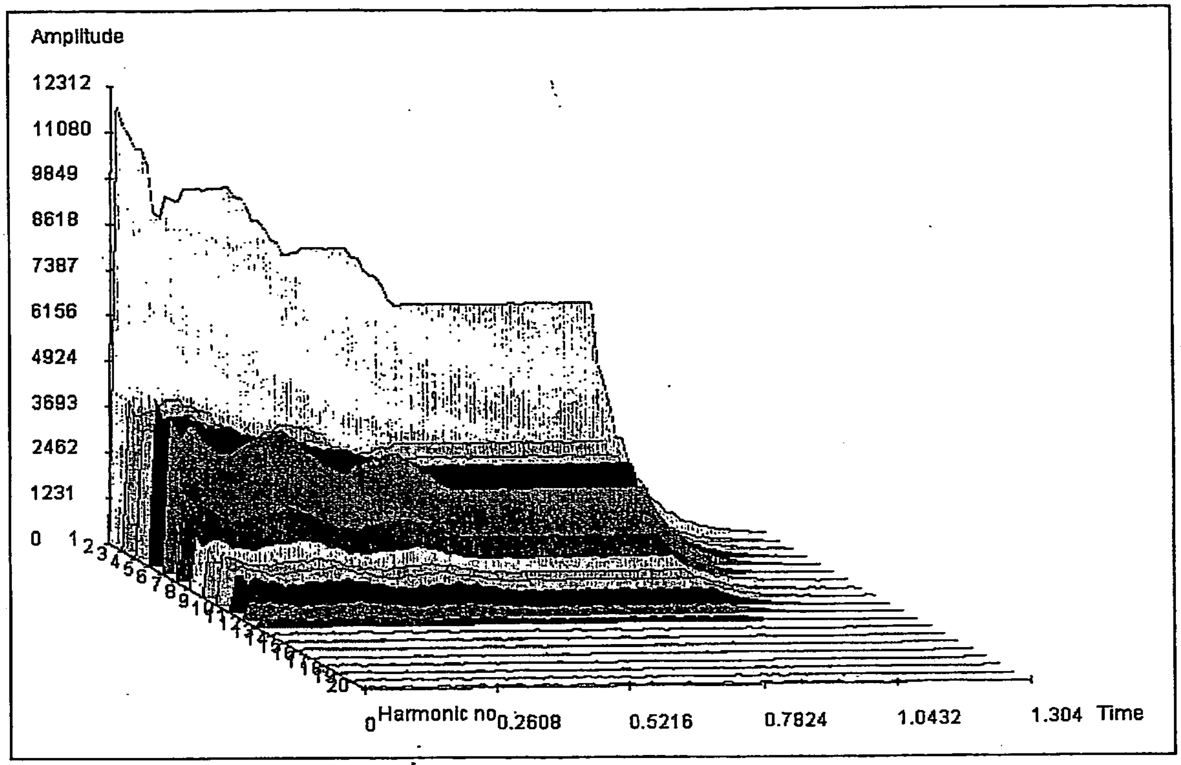

Amplitude
12312
11080
9849
8618
7387
6156
4924
3693
2462
1231
0
Harmonic no
0
0.2608
0.5216
0.7824
1.0432
1.304
Time

FIG. 16

deg	rad	2nd	3rd	sum	32767	1.9
0	0	0	0	0	0	32652
2.8125	0.049087	0.096817746	0.146730474	0.243548	4200	
5.625	0.098175	0.192703085	0.290284677	0.482988	8329	
8.4375	0.147262	0.286732587	0.427555093	0.714288	12318	
11.25	0.19635	0.378000698	0.555570233	0.933571	16100	
14.0625	0.245437	0.465628456	0.671558955	1.137187	19611	
16.875	0.294524	0.548771957	0.773010453	1.321782	22795	
19.6875	0.343612	0.626630484	0.85772861	1.484359	25598	
22.5	0.392699	0.698454217	0.923879533	1.622334	27978	
25.3125	0.441786	0.763551454	0.970031253	1.733583	29897	
28.125	0.490874	0.821295273	0.995184727	1.81648	31326	
30.9375	0.539961	0.87112957	0.998795456	1.869925	32248	
33.75	0.589049	0.912574412	0.98078528	1.89336	32652	
36.5625	0.638136	0.945230665	0.941544065	1.886775	32538	
39.375	0.687223	0.968783829	0.881921264	1.850705	31916	
42.1875	0.736311	0.983007075	0.803207531	1.786215	30804	
45	0.785398	0.987763426	0.707106781	1.69487	29229	
47.8125	0.834486	0.983007075	0.595699304	1.578706	27226	
50.625	0.883573	0.968783829	0.471396737	1.440181	24837	
53.4375	0.93266	0.945230665	0.336889853	1.282121	22111	
56.25	0.981748	0.912574412	0.195090322	1.107665	19102	
59.0625	1.030835	0.87112957	0.049067674	0.920197	15869	
61.875	1.079922	0.821295273	-0.09801714	0.723278	12473	
64.6875	1.12901	0.763551454	-0.24298018	0.520571	8977	
67.5	1.178097	0.698454217	-0.382683432	0.315771	5445	
70.3125	1.227185	0.626630484	-0.514102744	0.112528	1940	
73.125	1.276272	0.548771957	-0.634393284	-0.08562	-1477	
75.9375	1.325359	0.465628456	-0.740951125	-0.27532	-4749	
78.75	1.374447	0.378000698	-0.831469612	-0.45347	-7821	
81.5625	1.423534	0.286732587	-0.903989293	-0.61726	-10646	
84.375	1.472622	0.192703085	-0.956940336	-0.76424	-13180	
87.1875	1.521709	0.096817746	-0.98917651	-0.89236	-15390	
90	1.570796	1.21016E-16	-1	-1	-17246	
92.8125	1.619884	-0.096817746	-0.98917651	-1.08599	-18729	
95.625	1.668971	-0.192703085	-0.956940336	-1.14964	-19827	
98.4375	1.718058	-0.286732587	-0.903989293	-1.19072	-20535	
101.25	1.767146	-0.378000698	-0.831469612	-1.20947	-20859	
104.0625	1.816233	-0.465628456	-0.740951125	-1.20658	-20809	
106.875	1.865321	-0.548771957	-0.634393284	-1.18317	-20405	
109.6875	1.914408	-0.626630484	-0.514102744	-1.14073	-19673	
112.5	1.963495	-0.698454217	-0.382683432	-1.08114	-18646	
115.3125	2.012583	-0.763551454	-0.24298018	-1.00653	-17359	
118.125	2.06167	-0.821295273	-0.09801714	-0.91931	-15855	
120.9375	2.110758	-0.87112957	0.049067674	-0.82206	-14178	
123.75	2.159845	-0.912574412	0.195090322	-0.71748	-12374	
126.5625	2.208932	-0.945230665	0.336889853	-0.60834	-10492	
129.375	2.25802	-0.968783829	0.471396737	-0.49739	-8578	
132.1875	2.307107	-0.983007075	0.595699304	-0.38731	-6680	
135	2.356194	-0.987763426	0.707106781	-0.28066	-4841	
137.8125	2.405282	-0.983007075	0.803207531	-0.1798	-3101	
140.625	2.454369	-0.968783829	0.881921264	-0.08686	-1499	
143.4375	2.503457	-0.945230665	0.941544065	-0.00369	-64	
146.25	2.552544	-0.912574412	0.98078528	0.068211	1176	
149.0625	2.601631	-0.87112957	0.998795456	0.127666	2201	
151.875	2.650719	-0.821295273	0.995184727	0.173889	2998	

TABLE B

rad	5th	6th	7th	8th	9th	10th	11th	12th	sum	32767	2.2
0	0	0	0	0	0	0	0	0	0	0	32132
0.049087	-0.302850496	0.290284677	0.253341	0.205627	0.156775	0.113558	0.076955	0.049446	0.843137	-12557	
0.098175	-0.587548893	0.555570233	0.477064	0.37995	0.283447	0.200299	0.132013	0.082225	1.523018	-22683	
0.147262	-0.837031081	0.773010453	0.645012	0.496428	0.35569	0.239737	0.149507	0.08729	1.909644	-28442	
0.19635	-1.036343725	0.923879533	0.737551	0.53733	0.359633	0.22256	0.124461	0.062933	1.932003	-28775	
0.245437	-1.173540523	0.995184727	0.743861	0.496428	0.294519	0.152824	0.064	0.017363	1.590639	-23691	
0.294524	-1.240398243	0.98078528	0.663205	0.37995	0.172851	0.046997	-0.01467	-0.03406	0.954659	-14218	
0.343612	-1.232909602	0.881921264	0.505012	0.205627	0.017992	-0.06993	-0.08917	-0.074	0.144545	-2152	
0.392699	-1.151523449	0.707106781	0.287778	6.58E-17	-0.14032	-0.17034	-0.13829	-0.089	-0.69459	10346	
0.441786	-1.001117867	0.471396737	0.036899	-0.20563	-0.27169	-0.23052	-0.14807	-0.074	-1.42273	21191	
0.490874	-0.790707789	0.195090322	-0.21829	-0.37995	-0.35089	-0.23627	-0.11571	-0.03406	-1.93079	28758	
0.539961	-0.532904668	-0.09801714	-0.44797	-0.49643	-0.36271	-0.18622	-0.05043	0.017363	-2.15731	32132	
0.589049	-0.243160577	-0.382683432	-0.62527	-0.53733	-0.30488	-0.09219	0.029203	0.062933	-2.09337	31179	
0.638136	0.061157949	-0.634393284	-0.72946	-0.49643	-0.18851	0.023612	0.100524	0.08729	-1.77621	26456	
0.687223	0.361810822	-0.831469612	-0.74838	-0.37995	-0.03594	0.133835	0.143242	0.082225	-1.27463	18985	
0.736311	0.64077766	-0.956940336	-0.6798	-0.20563	0.12353	0.212453	0.145201	0.049446	-0.67096	9994	
0.785398	0.881337892	-1	-0.53174	-1.3E-16	0.259281	0.240897	0.105845	3.27E-17	-0.04438	662	
0.834486	1.06907294	-0.956940336	-0.32152	0.205627	0.345244	0.212453	0.036371	-0.04945	0.540861	-8055	
0.883573	1.192730434	-0.831469612	-0.07371	0.37995	0.364913	0.133835	-0.04345	-0.08223	1.040573	-15498	
0.93266	1.244898657	-0.634393284	0.182721	0.496428	0.314511	0.023612	-0.11091	-0.08729	1.429577	-21292	
0.981748	1.222450773	-0.382683432	0.417789	0.53733	0.203716	-0.09219	-0.14681	-0.06293	1.696671	-25270	
1.030835	1.126732255	-0.09801714	0.604012	0.496428	0.053803	-0.18622	-0.14094	-0.01736	1.838442	-27381	
1.079922	0.963480229	0.195090322	0.719619	0.37995	-0.10644	-0.23627	-0.09496	0.034059	1.854528	-27621	
1.12901	0.742479613	0.471396737	0.751094	0.205627	-0.24625	-0.23052	-0.02196	0.074001	1.745864	-26003	
1.178097	0.47697663	0.707106781	0.694757	1.97E-16	-0.33877	-0.17034	0.057283	0.089	1.516016	-22579	
1.227185	0.182884863	0.881921264	0.557195	-0.20563	-0.36624	-0.06993	0.12023	0.074001	1.174439	-17492	
1.276272	-0.122168564	0.98078528	0.35449	-0.37995	-0.32338	0.046997	0.148967	0.034059	0.739798	-11018	
1.325359	-0.419899513	0.995184727	0.110341	-0.49643	-0.21843	0.152824	0.135316	-0.01736	0.241544	-3597	
1.374447	-0.692462738	0.923879533	-0.14671	-0.53733	-0.07154	0.22256	0.083162	-0.06293	-0.28137	4191	
1.423534	-0.923521483	0.773010453	-0.38661	-0.49643	0.089096	0.239737	0.007345	-0.08729	-0.78466	11687	
1.472622	-1.099226664	0.555570233	-0.5813	-0.37995	0.232619	0.200299	-0.07056	-0.08223	-1.22478	18242	
1.521709	-1.209046954	0.290284677	-0.70804	-0.20563	0.331474	0.113558	-0.12839	-0.04945	-1.56524	23313	
1.570796	-1.2464	3.67545E-16	-0.752	-2.6E-16	0.366679	1.48E-16	-0.14969	-6.5E-17	-1.78141	26533	
1.619884	-1.209046954	-0.290284677	-0.70804	0.205627	0.331474	-0.11356	-0.12839	0.049446	-1.86278	27745	
1.668971	-1.099226664	-0.555570233	-0.5813	0.37995	0.232619	-0.2003	-0.07056	0.082225	-1.81217	26991	
1.718058	-0.923521483	-0.773010453	-0.38661	0.496428	0.089096	-0.23974	0.007345	0.08729	-1.64272	24467	
1.767146	-0.692462738	-0.923879533	-0.14671	0.53733	-0.07154	-0.22256	0.083162	0.062933	-1.37372	20461	
1.816233	-0.419899513	-0.995184727	0.110341	0.496428	-0.21843	-0.15282	0.135316	0.017363	-1.02689	15295	
1.865321	-0.122168564	-0.98078528	0.35449	0.37995	-0.32338	-0.047	0.148967	-0.03406	-0.62398	9294	
1.914408	0.182884863	-0.881921264	0.557195	0.205627	-0.36624	0.069929	0.12023	-0.074	-0.18629	2775	
1.963495	0.47697663	-0.707106781	0.694757	3.29E-16	-0.33877	0.17034	0.057283	-0.089	0.264483	-3939	
2.012583	0.742479613	-0.471396737	0.751094	-0.20563	-0.24625	0.230524	-0.02196	-0.074	0.704863	-10498	
2.06167	0.963480229	-0.195090322	0.719619	-0.37995	-0.10644	0.236269	-0.09496	-0.03406	1.108867	-16515	
2.110758	1.126732255	0.09801714	0.604012	-0.49643	0.053803	0.186216	-0.14094	0.017363	1.448778	-21578	
2.159845	1.222450773	0.382683432	0.417789	-0.53733	0.203716	0.092187	-0.14681	0.062933	1.697618	-25284	
2.208932	1.244898657	0.634393284	0.182721	-0.49643	0.314511	-0.02361	-0.11091	0.08729	1.832863	-27298	
2.25802	1.192730434	0.831469612	-0.07371	-0.37995	0.364913	-0.13384	-0.04345	0.082225	1.840393	-27410	
2.307107	1.06907294	0.956940336	-0.32152	-0.20563	0.345244	-0.21245	0.036371	0.049446	1.717473	-25580	
2.356194	0.881337892	1	-0.53174	-3.9E-16	0.259281	-0.2409	0.105845	9.81E-17	1.473822	-21951	
2.405282	0.64077766	0.956940336	-0.6798	0.205627	0.12353	-0.21245	0.145201	-0.04945	1.130379	-16835	
2.454369	0.361810822	0.831469612	-0.74838	0.37995	-0.03594	-0.13384	0.143242	-0.08223	0.716092	-10665	
2.503457	0.061157949	0.634393284	-0.72946	0.496428	-0.18851	-0.02361	0.100524	-0.08729	0.263627	-3926	
2.552544	-0.243160577	0.382683432	-0.62527	0.53733	-0.30488	0.092187	0.029203	-0.06293	-0.19484	2902	
2.601631	-0.532904668	0.09801714	-0.44797	0.496428	-0.36271	0.186216	-0.05043	-0.01736	-0.63071	9394	
2.650719	-0.790707789	-0.195090322	-0.21829	0.37995	-0.35089	0.236269	-0.11571	0.034059	-1.02041	15199	

TABLE C